Genetic Diversity of Stream Fish Populations in the Mid-Atlantic Region

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What does genetic diversity have to do with vulnerability assessments?

ReVA Endpoints:

- Resource Productivity
- Clean Drinking Water
- Biodiversity

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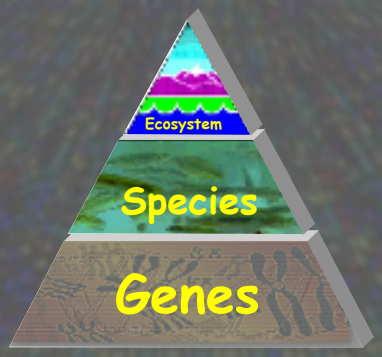
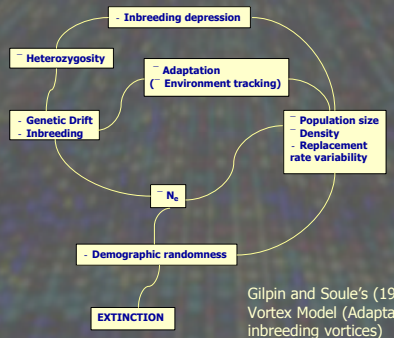


Genetic Diversity

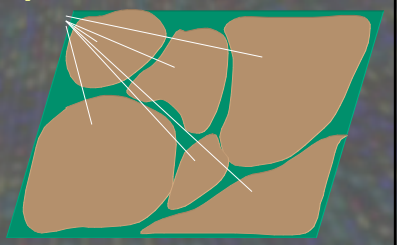
- Variation in the heritable portion of measurable traits that exists among individuals within a species.
  - Genetic diversity within populations
  - Genetic diversity among populations
- Examples: eye color, height, blood type, HIV resistance

? Environment þ ? Genetic Diversity þ ? Vulnerability



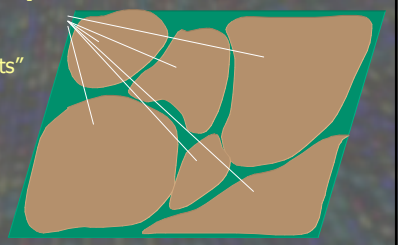
Gilpin and Soule's (1987) Extinction Vortex Model (Adaptation and inbreeding vortices)

Spatial distribution of genetically distinct resource populations (ESUs)

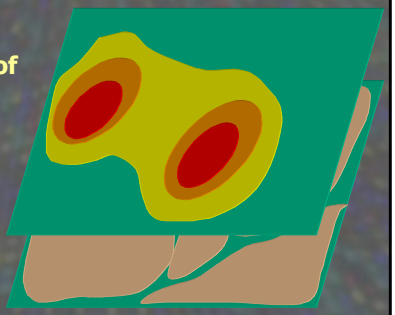


Spatial distribution of genetically distinct resource populations (ESUs)

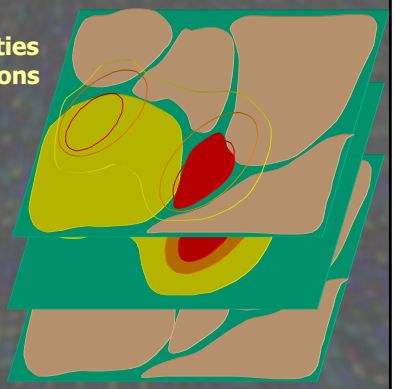
- Unique resources
- Biodiversity "Hotspots"



Spatial distribution of stressors



Relative vulnerabilities of populations



What does genetic diversity have to do with vulnerability assessments?

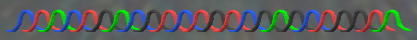
- Indicator of population's future "environmental buffering" ability
- Reflective of past population stressor history
- Defines the fundamental biological unit that we wish to assess (the population)
  - Prioritization based on uniqueness and vulnerability

Genetics of Creek Chubs in a Coal Mining Region of the Mid-Atlantic

Semotilus atromaculatus

Photo courtesy of Ohio Dept. Natural Resources

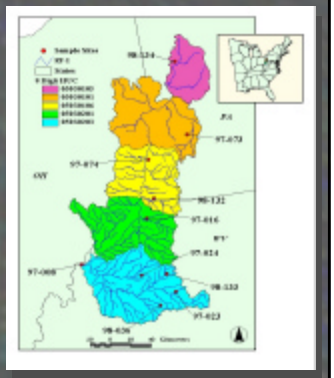
Study Questions

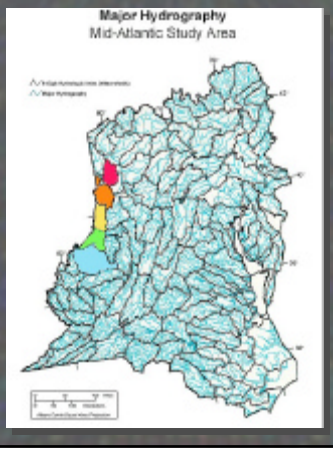


- Are there distinct population resources in the MAIA region?
- Do watershed boundaries (HUCs) predict stream population boundaries?
- Do levels of genetic diversity differ among sites?
- What is the relationship between genetic diversity and environmental condition?

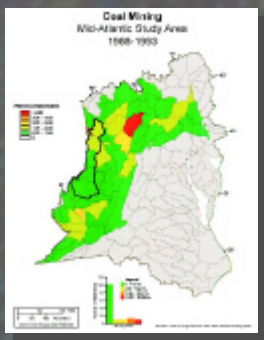
Study Area

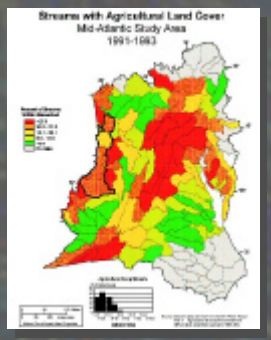
- Five watersheds assessed in MAIA pilot
- 10 sample sites
- Part of EMAP-MAIA 97-98 sampling
- Wadeable streams (second and third order)





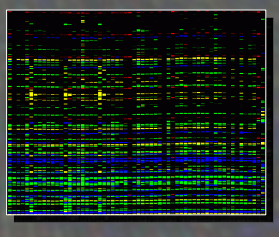
Major Environmental Concerns

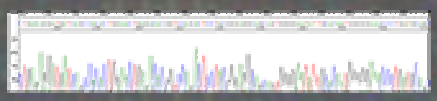




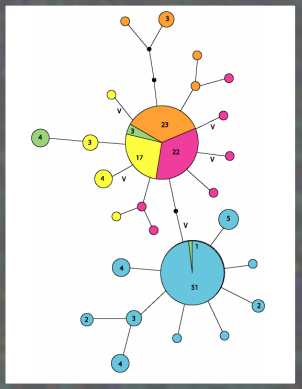
Genetic Analyses

- 10-28 fish sampled per site
- 590 bp of mitochondrial Cyt-B gene sequenced
- AFLP fingerprints based on 109 polymorphic markers
- Genetic differences within and among sites assessed by Analysis of Molecular Variance



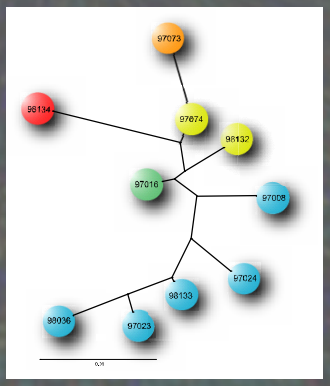


Population genetic structure



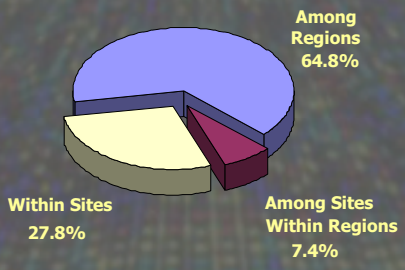
Mitochondrial DNA

Population genetic structure

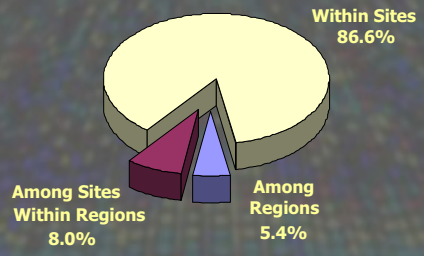


Nuclear DNA

Partitioning of Genetic Variance: Mitochondrial DNA



Partitioning of Genetic Variance: Nuclear DNA

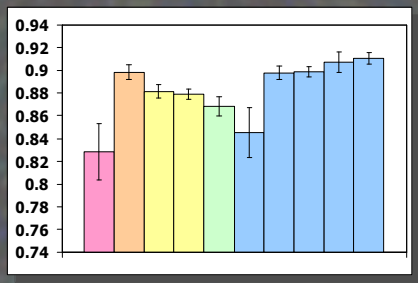


Study Questions

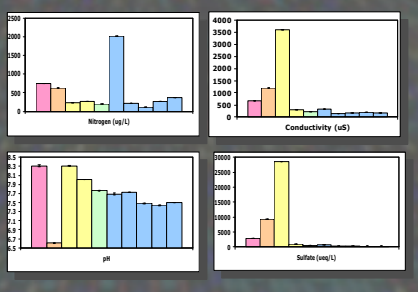
- Are there distinct population resources in the MAIA region? YES
- Do watershed boundaries (HUCs) predict stream population boundaries? NOT 1:1

- Do levels of genetic diversity differ among sites?
- What is the relationship between genetic diversity and environmental condition?

Average Genetic Similarity



Each site characterized with 25 environmental measures



Principal Components Analysis

Principal component	Variation explained	Variables
1 (Geochemistry)	37.4%	Conductivity, aluminum, calcium, chloride, potassium, magnesium, sodium, sulfate
2 (N/P/C)	24.3%	Nitrate, total nitrogen, total phosphorus, organic carbon
3 (Latitudinal clines)	14.1%	Latitude, elevation, channel slope, silica, zinc
4 (Spatial scale)	11.8%	Watershed area, stream width, stream depth
5 (pH-Ammonium)	6.7%	pH, Ammonium
6 (Substrate condition)	6.3%	Pebble size, embededness, percent riffle

Stepwise multiple regression
nuclear DNA diversity

PCA Factor	Partial r^2	Model r^2	F	P>F
PCA 3 (Latitudinal clines)	0.433	0.433	6.10	0.039
PCA 2 (N/P/C)	0.349	0.792	12.06	0.010
PCA 5 (pH/Ammonium)	0.184	**0.976**	45.6	0.005

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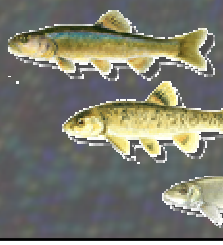
- Do watershed boundaries (HUCs) predict stream population boundaries? NOT 1:1

- Do levels of genetic diversity differ among sites? YES
- What is the relationship between genetic diversity and environmental condition? APPEARS TO BE STRONG

Complete Study

- 3 stream minnows
- MAIA and WAP
- To be completed later this year



Acknowledgements

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